NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE LOW-PRESSURE, UNDERGROUND, PLASTIC PIPELINE

(Ft.)

CODE 430EE

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

To prevent erosion or loss of water quality or damage to the land, to make possible the proper management of irrigation water, and to reduce water conveyance losses.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to underground thermoplastic pipelines from 4 to 18 inches in diameter that are subject to internal pressures up to 50 lb/in^2.

The standard includes the design criteria for these irrigation pipelines and minimum installation requirements. It applies to pipelines with stands and vents open to the atmosphere and to pipelines not open to the atmosphere but provided with pressure-relief valves and air-vent and vacuum-relief valves.

All pipelines shall be planned and located to serve as an integral part of an irrigation water distribution or conveyance system designed to facilitate the conservation use and management of the soil and water resources on a farm or group of farms.

CRITERIA

General Criteria Applicable to All Purposes

The water supply, water quality, and rate of irrigation delivery for the area served by the pipeline shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Plastic pipelines shall be placed only in suitable soils where the bedding and backfill requirements can be fully met.

Laws, rules, and regulations. This practice shall conform to all federal, state, and local laws, rules, and regulations. Laws, rules, and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

Working pressure. The pipeline shall be designed to meet all service requirements without a static or working pressure, including hydraulic transients, at any point greater than the maximum allowable working pressure of the pipe used at that point. The static or working pressure of pipelines open to the atmosphere shall include freeboard.

Maximum allowable working pressure for low-head plastic irrigation pipe shall be 50 feet or head or 22 lb\in^2.

Pipelines constructed of 50-lb/in^2 plastic irrigation pipe or the IPS pipe covered by this standard shall have a working pressure no greater than 50 lb\in^2.

Plastic pipeline requiring a working pressure greater than 50 lb/in^2 shall be constructed according to the requirements specified in Conservation Practice Standard 430-DD, Irrigation Water Conveyance High-Pressure, Underground, Plastic Pipeline.

Plastic pipe pressure rating normally is based on a water temperature of 73.4^o F. Factors for adjusting allowable working pressure for higher water temperature are given in Table 1.

Table 1 - Pressure rating factors for polyvinyl chloride (PVC) and PE pipe for water at elevated temperatures

Temperature deg F	PVC	PE
73.4	1.00	1.00
80	.88	.92
90	.75	.81
100	.62	.70
110	.50	—
120	.40	—
130	.30	—
140	.22	—

To obtain the pipe's reduced pressure rating because of a water temperature greater than 73.4^{o} F, multiply the normal pressure rating by the appropriate factor from Table 1.

Friction losses. For design purposes, friction head losses shall be no less than those computed by the Hazen-Williams equation using a roughness coefficient, C, equal to 150.

Flow velocity. The full pipe design water velocity in the pipeline when operating at system capacity should not exceed 5 ft/s.

Capacity. Capacity shall be sufficient to provide an adequate irrigation stream for the irrigation application methods or planned storage.

Design capacity of the pipeline conveyance or distribution system shall be based on one of the following:

1. Adequate to meet the moisture demands of all crops to be irrigated in the design area.
2. Sufficient to meet the requirements of selected irrigation events during critical crop growth periods when less than full irrigation is planned.
3. For special-purpose irrigation systems, sufficient to apply a stated amount of water to the design area in a specified net operating period.
4. Sufficient to meet the requirements for efficient application with the distribution system.

In computing the above capacity requirements, allowance must be made for reasonable water losses during application or use.

Outlets. Appurtenances to deliver water from the pipe system to the field, ditch, reservoir, storage, or surface pipe system are known as outlets. Outlets shall have adequate capacity to deliver the required flow to:

1. The hydraulic gradeline of a pipe or ditch.
2. A point at least 6 inches above the field surface.
3. The design surface elevation in a reservoir.
4. An individual sprinkler, lateral line, hydrant, or other device at the required operating pressure.

Outlets shall be designed to minimize erosion, physical damage, or deterioration caused by exposure.

Check valves. A check valve shall be installed between the pump discharge and the pipeline if backflow may occur.

Stands open to the atmosphere. Stands shall be used wherever water enters the pipeline system to avoid entrapment of air, to prevent surge pressures, to avoid collapse because of negative pressures, and to prevent the pressure from exceeding the maximum allowable working pressure of the pipe. Open stands may be required at other locations in low-head systems to perform other functions. Stands shall be constructed of steel pipe or other approved material and be supported on a base adequate to support the stand and prevent movement or undue stress on the pipeline. Open stands shall be designed to meet or exceed the following criteria:

1. Each stand shall allow at least 1 foot of freeboard above design working head. The stand height above the centerline of the pipeline shall be such that neither the static head nor the design working head plus free-board exceeds the allowable working pressure of the pipe.
2. The top of each stand shall extend at least 4 feet above the ground surface except for surface gravity inlets or where visibility is not a factor. Gravity inlets shall be equipped with trash guards.
3. The downward water velocity in stands shall not exceed 2 ft/s. The inside diameter of the stand shall not be less than the inside diameter of the pipeline. This downward

velocity criterion applies only to stands having vertical offset inlets and outlets.

4. If the water velocity in the inlet (from the pump or other water source) equals or exceeds 3 times the velocity in the outlet pipeline, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.
5. The cross-sectional area of stands may be reduced above a point 1 foot above the top of the upper inlet or outlet pipe, but the reduced cross-section shall not be such that it would produce an average velocity of more than 10 ft/s if the entire flow were discharging through it.
6. Vibration-control measures, such as special couplers or flexible pipe, shall be provided as needed to ensure that vibration from pump discharge pipes is not transmitted to stands.

Sand traps, when combined with a stand, shall have minimum inside dimensions of 30 inches and shall be constructed so that the bottom is at least 24 inches below the invert of the outlet of the pipeline. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 ft/s.

Gate stands shall be of sufficient dimension to accommodate the gate or gates and shall be large enough to make the gates accessible for repair.

Float valve stands shall be large enough to provide accessibility for maintenance and to dampen surge.

Stands closed to the atmosphere. If pressure-relief valves and air-vacuum valves are used instead of open stands, all requirements under “Stands open to the atmosphere” shall apply except as modified below.

The inside diameter of the closed stand shall be equal to or greater than that of the pipeline for at least 1 foot above the top of the uppermost inlet or outlet pipe. To facilitate attaching the pressure-relief valve and the air-vent and vacuum-relief valve, the stand may be capped at this point; or if additional height is required, the stand may be extended to the desired elevation by using the same inside diameter or a reduced cross-section. If a reduced section is used, the cross-sectional area shall be such that it would produce an average velocity of no more than 10 ft/s if the entire flow were discharged through it. If no vertical offset is required between the pump discharge pipe and the outlet pipeline and the discharge pipe is “doglegged” below ground, the stand shall extend to a least 1 foot above the highest part of the pump discharge pipe.

An acceptable alternative design for stands requiring no vertical inlet (when inlet velocity is less than 3 times that of the outletting pipeline) shall be to:

1. Construct the dogleg section of the pump discharge pipe with the same nominal diameters as that of the pipeline.
2. Install the pressure-relief valve and the air-vent and vacuum-relief valve on top of the upper horizontal section of the dogleg.

Pressure-relief and air-vent and vacuum-relief valves shall be installed on stands with nominal size pipe required to fit the threaded inlets of the valves.

Vents. Vents must be designed into systems open to the atmosphere to provide for the removal and entry of air and protection from surge. They shall:

1. Have a minimum freeboard of 1 foot above the hydraulic gradeline. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum allowable working pressure of the pipe.
2. Have a cross-sectional area at least ½ the cross-sectional area of the pipeline (both inside measurements) for a distance of at least 1 pipeline diameter up from the centerline of the pipeline. Above this elevation, the vent may be reduced to 2 inches in diameter.

   These cross-sectional requirements shall apply when an air-vent and vacuum-relief valve is used instead of a vent, but the reduced section shall be increased to the nominal size pipe required to fit the threaded inlet of the valve. An acceptable alternative is to install this valve in the side of a service outlet, provided that the riser is properly located and adequately sized. If both an air-vent and vacuum-relief valve and a pressure-relief valve are required at the location, the 10-ft/s velocity criterion given under “Stands open to the atmosphere” shall apply to the reduced section.

3. Be located at the downstream end of each lateral, at summits in the line, and at points where there are changes in grade in a downward direction of flow of more than 10 degrees.

Air-vent and vacuum-relief valves. An air-vent and vacuum-relief valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filling operations and allows air to reenter the line and prevents a vacuum from forming during emptying operations. It is not continuous-acting because it does not allow further escape of air at working pressure once the valve closes.

Air-vent and-vacuum-relief can be used instead of open vents.

Air-vent and vacuum-relief valves installed according to “Stands Closed to the Atmosphere” can be used in conjunction with pressure-relief valves as an alternative to open pump stands. A pipeline is considered open to the atmosphere if at least 1 stand, vent, or service outlet is unclosed and located so that it cannot be isolated from the system by line gates or valves.

The diameter of the orifice (opening that controls air flow during filling and emptying operations) of an air-vent and vacuum-relief valve shall equal or exceed that specified in Table 2 for the appropriate diameter of pipeline.

Table 2 - Diameter of orifice for an air-vent and vacuum-relief valve

Diameter of orifice *(in)*	Diameter of pipeline *(in)*
¾	4
1¼	6
1¾	8
2¼	10
2¾	12
3¼	14
3½	15
3¾	16
4	18

Manufacturers of air-vent and vacuum-relief valves marketed for use under this standard shall provide dimensional data, which shall be the basis for selecting and accepting these valves.

Pressure-relief valves. Pressure-relief valves can be used on low-pressure plastic pipelines as an alternative to stands open to the atmosphere. A pressure-relief valve shall serve the pressure-relief function of the open stand or vent for which it is an alternative.

Pressure-relief valves do not function as air-release valves and shall not be used as substitutes for such valves if release of entrapped air is required. Pressure-relief valves shall be used in conjunction with air-vent and vacuum-relief valves at all pump stands and at the end of pipelines, if needed, to relieve surge at the end of the lines.

The flow capacity of pressure-relief valves shall be the pipeline design flow rate with a pipeline pressure no greater than 50 percent more than the permissible working pressure for the pipe.

The pressure at which the valve starts to open shall be marked on each pressure-relief valve. Adjustable pressure-relief valves shall be sealed or otherwise altered to insure that the adjustment marked on the valve is not changed.

Manufacturers of pressure-relief valves marketed for use under this standard shall provide capacity tables, based on performance tests, that give the discharge capacity of the valves at the maximum permissible pressure and differential pressure settings. Such tables shall be the basis for design of pressure setting and of acceptance of these valves.

Drainage. Provisions shall be made for completely draining the pipeline if a hazard is imposed by freezing temperatures. If provisions for drainage are required, drainage outlets shall be located at all low places in the line. These outlets can drain into dry wells or to points of lower elevation. If drainage cannot be thus provided by gravity, provisions shall be made for emptying the line by pumping or by other means.

Flushing. If provisions are needed for flushing the line free of sediment or other foreign material, a suitable valve shall be installed at the distant end of the pipeline.

Thrust control. Anchors or thrust blocks shall be provided on pipelines having a working pressure of 25 lb/in^2 or greater at abrupt changes in pipeline grade, changes in horizontal alignment, or reduction in pipe size to absorb any axial thrust of the pipeline. Thrust blocks may also be needed at the end of the pipeline and at inline control valves.

The pipe manufacturer's recommendations for thrust control shall be followed. In the absence of such recommendations, the following equation should be used to design thrust blocks:

$$A = [(98\ HD^2)/B]\sin(a/2)$$

Where:

A = Area of thrust block required in ft^2
H = Maximum working pressure in feet
D = Inside diameter of pipe in feet
B = Allowable passive pressure of the soil in lb/ft^2
a = Deflection angle of pipe bend

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90-degree pipe bend.

If adequate soil tests are not available, the allowable bearing soil pressure can be estimated from Table 3.

Table 3 - Allowable soil bearing pressure

Natural Soil Material	Depth of Cover to Center of Thrust Block 2 ft	3 ft	4 ft	5 ft
	lb/ft^2			
Sound bedrock	8,000	10,000	10,000	10,000
Dense sand and gravel mixture (assumed Ø = 40°)	1,200	1,800	2,400	3,000
Dense fine to coarse sand (assumed Ø = 35°)	800	1,200	1,650	2,100
Silt and clay mixture (assumed Ø = 25°)	500	700	950	1,200
Soft clay and organic soils (assumed Ø = 10°)	200	300	400	500

Materials. All materials described and required in this standard shall meet or exceed the minimum requirements listed for materials under "Plans and Specifications."

CONSIDERATIONS

If irrigation application methods (for example, trickle irrigation) have limiting working pressures, pressure-relief valves should be considered to ensure the pressure created in the pipeline does not exceed the allowable pressure.

Chemigation valves (that is, double-seated check valves with air-relief valve and low-pressure drain) should be used on all pipelines in which fertilizer, pesticides, acids, or other chemicals are added to the water supply and where drainage may contaminate the mainline, water supply, or ground water.

Where pipelines are to be drained, consideration should be given to disposal of drained water.

Consideration should be given to the direction of water leaving an air valve or pressure-relief valve. If possible, the flow should be directed away from electrical equipment and hook-ups.

Design processes should consider safety elements when installations are effected by utilities.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing low-pressure, underground, plastic irrigation pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be developed for each pipeline system installed. The plan should document needed actions to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be included as an identifiable part of the design. Depending on the scope of the project, this may be accomplished by brief statements in the plans and specifications, the conservation plan narrative, or as a separate O&M plan.

Other aspects of O&M, such as drainage procedures, defining crossing location, valve(s) operation to prevent pipe or appurtenant damage, other appurtenance or pipe maintenance, and recommended operating procedures, should be described as needed within the O&M plan.